PART A: FILE REVIEW
LANDSLIDE RISK ASSESSMENT
PEACE REGION (PEACE RIVER VALLEY/HIGH LEVEL)

SITE PH6: TOMPKINS LANDING

LEGAL LOCATION:	30-103-19-W5M
Location along Highway:	17+360 (according to design layout, this is 250 m from the ferry dock).
AI FILE:	SH697:02
Date of Initial Observation:	1990
Date of Last Inspection:	June 1999
Instruments Installed:	13 slope inclinometers
Instruments Operational:	5 slope inclinometers
Risk Assessment:	PF(13) * CF(2) = **26**
Last Updated:	AMEC Earth & Environmental Limited November 1, 2000

INTRODUCTION

This section is a review of files made available by Alberta Infrastructure for the site. The file review was prepared prior to the site visit. The description of the sites is based on the information that was present in the file, topographical and geological information was added if it was not present in the file and if the site was familiar, previous observations were also included. A risk assessment, solely based on the file review is provided. The risk assessment may change once the observations made during the site visit are incorporated.

The Tompkins Landing site is located on SH697:02 on the west side of the Peace River, approximately 250 m from the ferry crossing. The road descends into the valley of the Peace River, dropping approximately 85 m. At the site, the road runs parallel with the Peace River, at approximately 20 m above river level. The slope leading to the river is inclined at 2.5H:1V.

GEOTECHNICAL CONDITIONS

At the site, the Peace River follows a preglacial valley, filled in with lacustrine clay and clay till. The stratigraphy at the site consists of lacustrine clay, clay till containing sand and gravel layers, underlain by clay shale. The lacustrine clay and the clay till are typically medium to high plastic. The clay shale is probably of the Shaftsbury Formation.

Formation of the valley of the Peace River was accompanied with extensive sliding. Thus, it is expected that the material is pre-sheared and that low strengths are being mobilized.

CHRONOLOGY

Table A1 provides the chronological background of the slides.

DESCRIPTION OF INDIVIDUAL SITES

In the following, the individual sites are described.

Station 17+360, 250 m from Ferry Dock

Description of Instability

The road was constructed in cut and fill. At the site, two culverts were installed in a draw and up to 9 m of fill was placed as shown on the design drawings.

In 1990, extensive longitudinal cracks had developed in the roadway, after heay precipitation and recession of the flood water in the Peace River (the water had been 6 m higher than during a site visit later that year).

The failure appears to be deep-seated with the surface of rupture mostly passing through the clay shale. The extent of the failure uphill of the road is not clear. GAEA has suggested that the failure may be the lowest failure block of a retrogressive failure of the valley wall. However, this has not been investigated. GAEA has also noted that the

air photos indicate that there is a large landslide scar just to the south of the failure. The current failure may be part of that landslide movement.

The soil conditions at the road embankment consist of (from the top down) clay fill, an organic layer, clay till, sand and gravel and clay shale. The clay fill appears to be derived from clay till; it is described as gravelly, sandy, silty, stiff to hard. The maximum thickness of the fill encountered in the boreholes is 4.5 m; however, according to the design drawings, up to 9 m of fill was placed. The clay till is described as gravelly, sandy, silty clay, firm to hard. The clay till is underlain by sand and gravel, which appears to be water-bearing. The sand and gravel is underlain by clay shale, which is weathered and contains harder and softer layers. This shale probably belongs to the Shaftsbury formation.

Past Investigation

In 1990, nine test pits were excavated and seven slope inclinometers (1 to 7) were installed at the site. A borehole log for slope inclinometer 7 is in the file.

In 1998, four slope inclinometers (10 to 13) were installed. Borehole logs are in the file.

Remedial Measures

In 1999, GAEA proposed drainage measures, rehabilitation of the culverts and installation of a pile wall. The estimated cost was $ 436,000. No remedial measures have been implemented.

Monitoring Results

Slope inclinometer 11 registered almost 40 mm in a one-year period in 1998. Movement occurred in a distinct shear zone at 14 m depth. It has sheared off.

Slope inclinometer 3 registered distinct shear movement at 13 m depth in 1996. I t appears to have sheared off.

All the other slope inclinometers have registered either surficial movement or movement that suggests tilting. Since the slope inclinometers were relatively shallow (from 11 m to 18 m deep), the rupture surface may be below the bottom of the slope inclinometers.

Assessment

The following factors appear to have caused or affected the slide movement:

- placement of fill for the construction of the road would probably have adversely affected stability of the slope.
- the fill may have blocked the flow of water through the sand and gravel layers; this is indicated by the high water table in the sand and gravel in Boreholes 10 and 11;
- it is reported that prior to the initial failure in 1990, flood waters had receded; thus, it appears that the initial failure may have been a rapid drawdown failure;

- the strength of the shale may have been reduced to a residual value after the initial failure.

GAEA presents a failure surface in the 1999 geotechnical review report. The interpretation is mostly based on the slope inclinometer readings. In a number of slope inclinometers, it is not clear whether movement has actually occurred at the depths indicated. Only slope inclinometers 3 and 11 indicate a clear shear zone, some of the other slope inclinometers display gradual tilting, which may appear that way because they have not been installed deep enough. The failure surface shown in Figure 1 reflects this interpretation.

Risk Assessment:
The probability factor is 13. Slope inclinometer 11 indicates movement of 40 mm in one year, but it is not clear whether this has resulted in significant movement of the road or whether the road has required periodic repairs. The consequence factor is 2, it appears that the road could be shifted uphill temporarily if required. Thus, the risk level is estimated at 26.

TABLE A1: CHRONOLOGY

1982	Constructed improvement to the alignment.
1990, 10	Memorandum by V. Diyaljee to G. Stone. Site was visited and test pits were excavated in August 1990. A survey of the slopes was completed. Cracks were observed encroaching to 1/3 of centreline of fill section of road at 17+360 (approximately 250 m south of the ferry crossing). Cracks were approximately 100 m long and were concentrated in upper 10 m of the slope. A slide had not yet developed. Cracks had started opening up after recession of the flood water in the Peace River after high precipitation in July 1990. The high water mark was approximately 6 m above the water level at the time of the site visit (1/3 slope height). Slope inclination was at 2.5H:1V. Study of design mosaic indicated that at this area over 9 m fill was placed over a draw and the fill extended from the tree line to the river bank. Nine test pits were excavated to 5 m depth. The soil conditions were sandy silt and varved clay, with occasional permafrost (?). In six of the nine test pits seepage flow was observed (at the interface between native and fill material). The interpretation was that the failure was caused by rapid drawdown. In addition, long-term adverse seepage conditions may have existed due to the fill placed on native ground. It was recommended that slope inclinometers be installed. Proposed remedial measures were drains and a toe berm.
1990, 10	Note to file by K.Li to G. Newman. Request to install slope inclinometers.
1994, 08	Memorandum by V. Diyaljee to R. Callioux. Monitoring of the slide indicates rates of movement in the order of 100 mm per year. Movement is deep-seated. A shift of the alignment may be required.
1998, 03	GAEA Slope inclinometer installation report. Four slope inclinometers were installed at slide area (Station 17+325 and 17+370).

1999, 03 GAEA Geotechnical investigation report. The report presents a review of the slide area. Culverts crossing the road are shown on the 1981 design drawing for the road at Station 17+320 and 17+335. Slope inclinometers indicate deep-seated movement in the shale. A review of air photos indicates that there is a large slide scarp adjacent or at the site. It appears that the slide may be part of a number of slide blocks extending further up the slope; however, this was not confirmed, because no instrumentation was installed uphill of the current slide. Possible reasons for the slide are:

- natural drainage is blocked at the slope;
- the slope may be affected by a landslide scarp south of Station 17+350;
- the weight of the fill may affect the stability of the slope adversely.

A number of remedial measures were considered:

- re-alignment, high cost;
- shear key and toe berm, not considered viable because the slide plane is below river level;
- partial replacement of existing road fill by lightweight fill;
- pile wall, if necessary anchored at a later date;
- drainage measures, trench drains are preferred.

It was recommended that the culverts in the drainage course be inspected. Costs for drainage measures, rehabilitation of the culverts and installation of a pile wall were presented ($ 436,700).